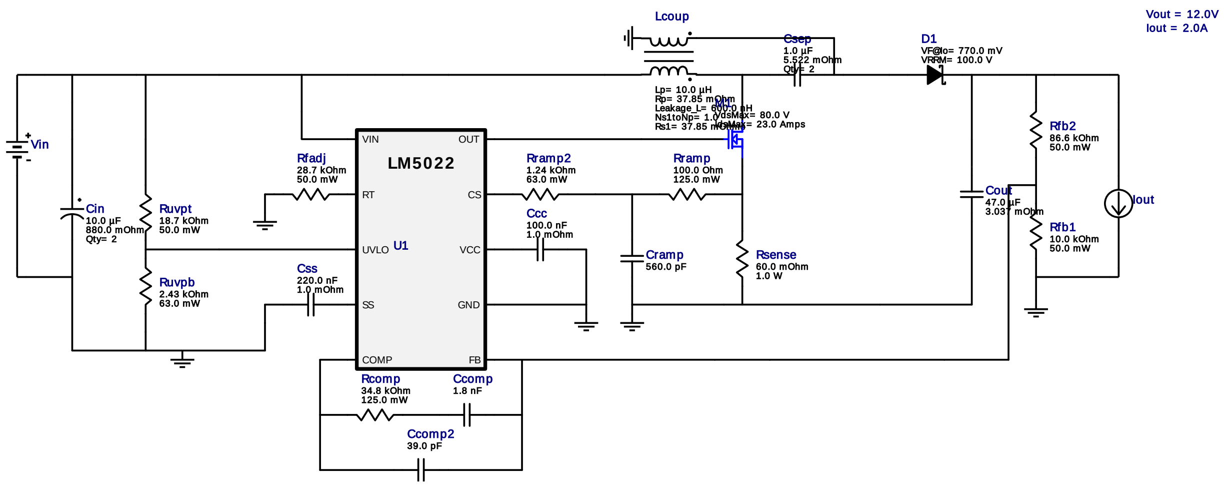
VinMin = 12.0V
VinMax = 30.0V
Vout = 12.0V
Iout = 2.0A

Device = LM5022MM/NOPB
Topology = SEPIC
Created = 2019-02-10 17:34:16.284
BOM Cost = $3.97
BOM Count = 23
Total Pd = 3.53W

WEBENCH ® Design Report

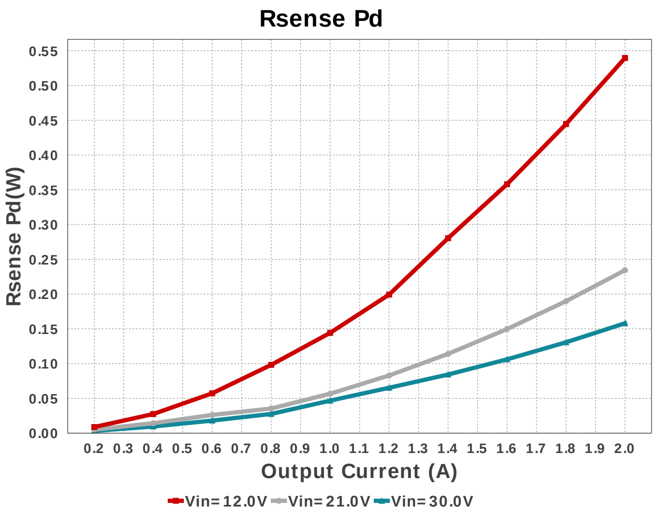
Design : 2 LM5022MM/NOPB
LM5022MM/NOPB 12V-30V to 12.00V @ 2A

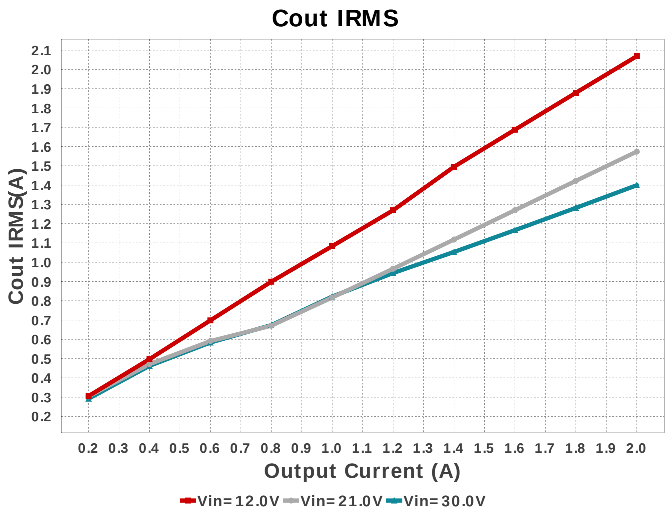


Electrical BOM

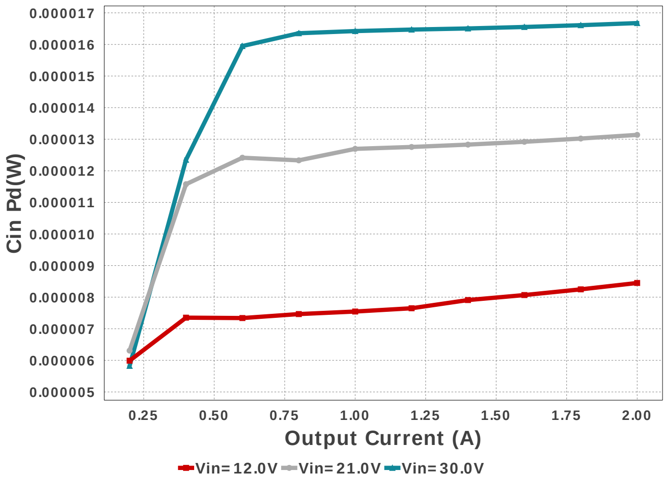
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Ccc	Kemet	C0603C104Z4VACTU Series= Y5V	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Ccomp	TDK	CGA4C2C0G1H182J060AA Series= C0G/NP0	Cap= 1.8 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm^2
Ccomp2	Samsung Electro-Mechanics	CL21C390JBANNNC Series= C0G/NP0	Cap= 39.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Cin	Nichicon	UUD1H100MCL1GS Series= uD	Cap= 10.0 uF ESR= 880.0 mOhm VDC= 50.0 V IRMS= 165.0 mA	2	$0.11	SM_RADIAL_6.3AMM 80 mm^2
Cout	MuRata	GRM32ER61C476ME15L Series= X5R	Cap= 47.0 uF ESR= 3.037 mOhm VDC= 16.0 V IRMS= 4.59346 A	1	$0.38	1210_280 15 mm^2
Cramp	MuRata	GRM1555C1H561JA01J Series= C0G/NP0	Cap= 560.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Csep	TDK	C1608X5R1H105K080AB Series= X5R	Cap= 1.0 uF ESR= 5.522 mOhm VDC= 50.0 V IRMS= 2.2162 A	2	$0.04	0603 5 mm^2
Css	Kemet	C0603C224Z4VACTU Series= Y5V	Cap= 220.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
D1	Vishay-Semiconductor	50WQ10FNPBF	VF@Io= 770.0 mV VRRM= 100.0 V	1	$0.81	DPAK 102 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Lcoup	Coiltronics	DRQ125-100-R	Lp= 10.0 µH Rp= 37.85 mOhm Leakage_L= 600.0 nH Ns1toNp= 1.0 Rs1= 37.85 mOhms	1	$0.91	DRQ125 210 mm²
M1	Infineon Technologies	BSC340N08NS3 G	VdsMax= 80.0 V IdsMax= 23.0 Amps	1	$0.27	PG-TDSON-8 55 mm²
Rcomp	Panasonic	ERJ-6ENF3482V Series= ERJ-6E	Res= 34.8 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
Rfadj	Yageo	RC0201FR-0728K7L Series= ?	Res= 28.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rfb1	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rfb2	Yageo	RC0201FR-0786K6L Series= ?	Res= 86.6 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rramp	Vishay-Dale	CRCW0805100RFKEA Series= CRCW..e3	Res= 100.0 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
Rramp2	Vishay-Dale	CRCW04021K24FKED Series= CRCW..e3	Res= 1.24 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rsense	Stackpole Electronics Inc	CSRN2010FK60L0 Series= ?	Res= 60.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	$0.15	2010 32 mm²
Ruvpb	Vishay-Dale	CRCW04022K43FKED Series= CRCW..e3	Res= 2.43 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Ruvpt	Yageo	RC0201FR-0718K7L Series= ?	Res= 18.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
U1	Texas Instruments	LM5022MM/NOPB	Switcher	1	$0.99	MUB10A 24 mm²

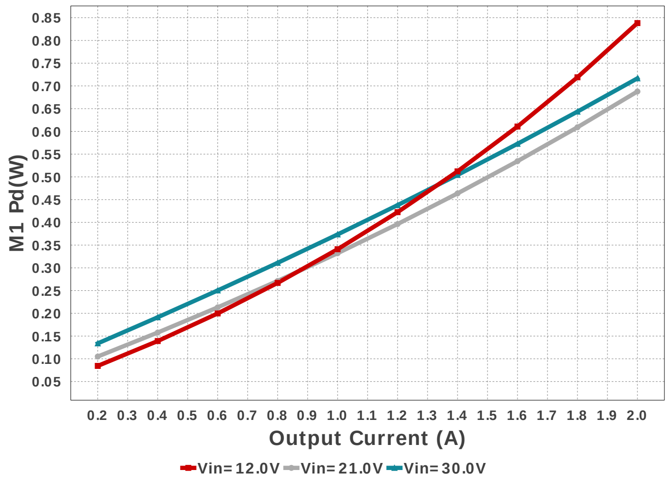




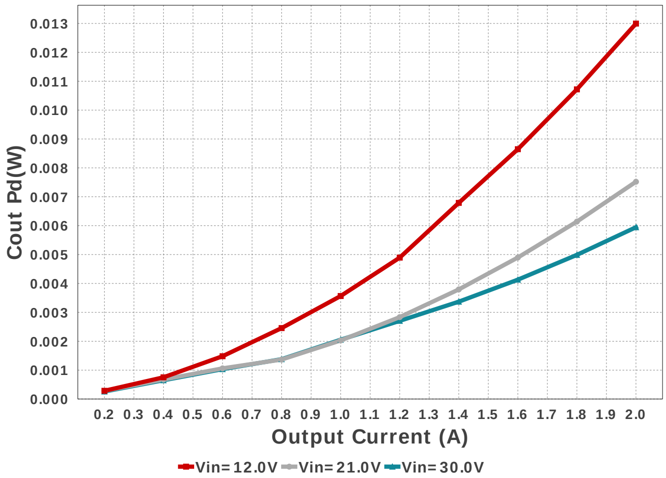
Cin Pd



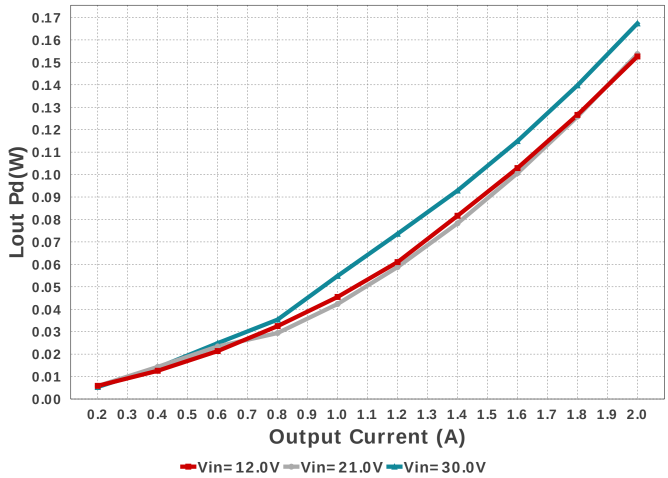
M1 Pd



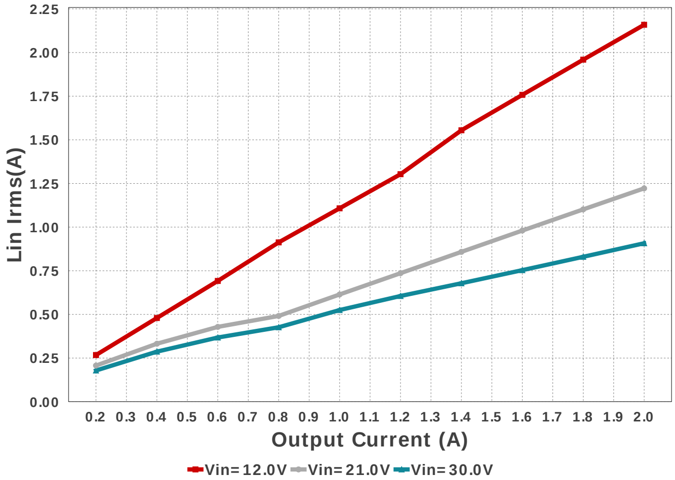
Cout Pd



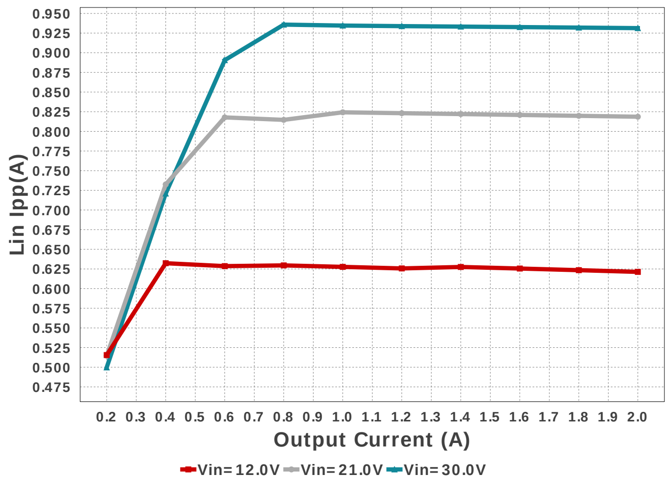
Lout Pd

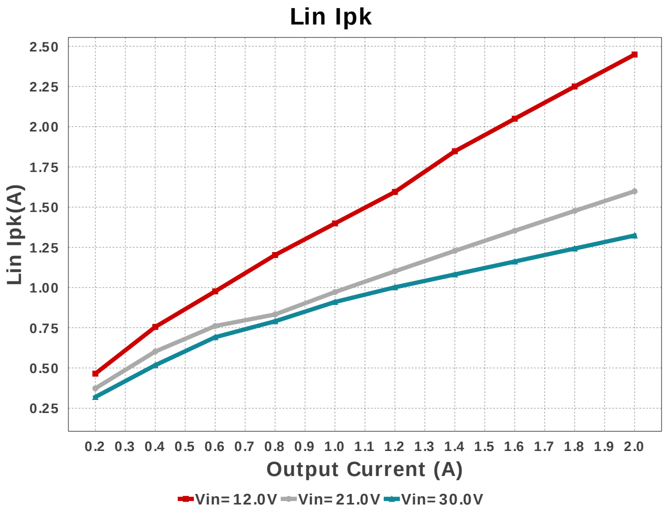


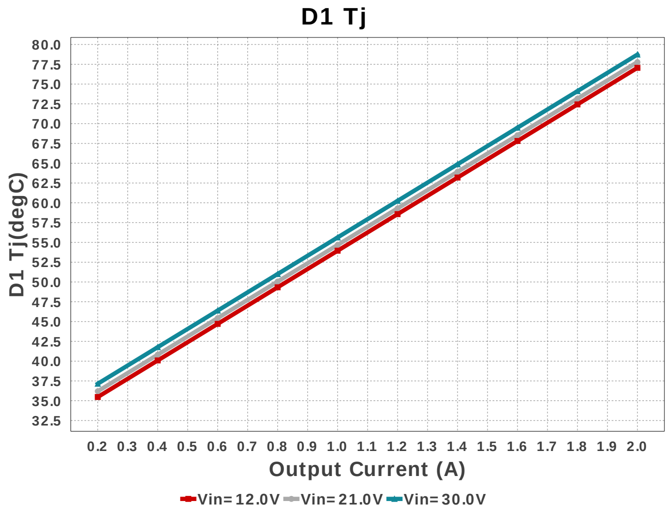
Lin Irms

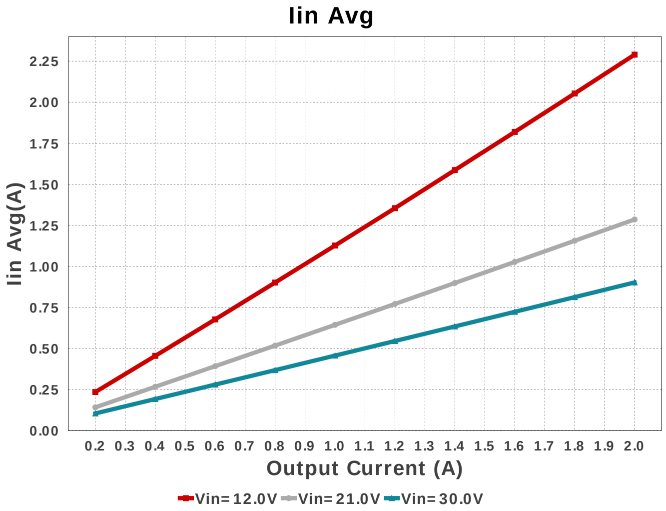


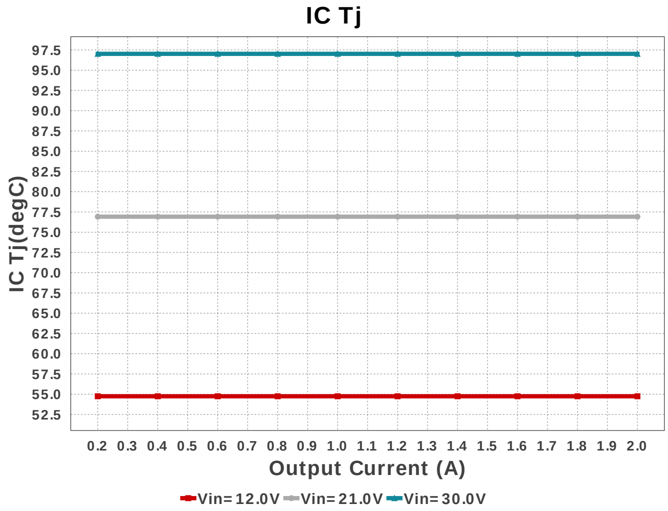
Lin Ipp

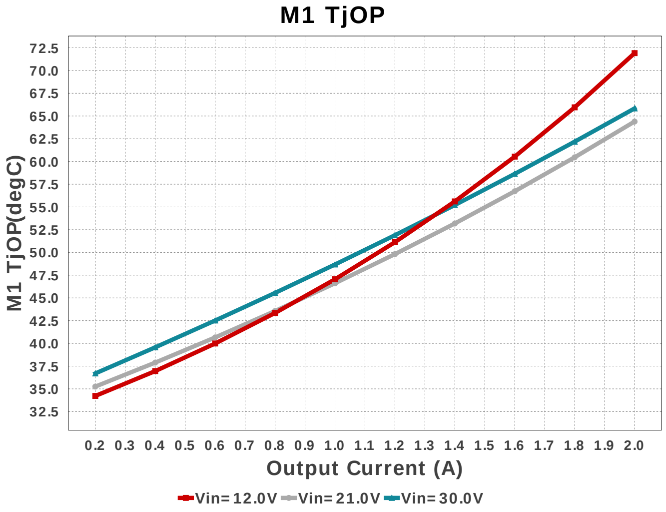


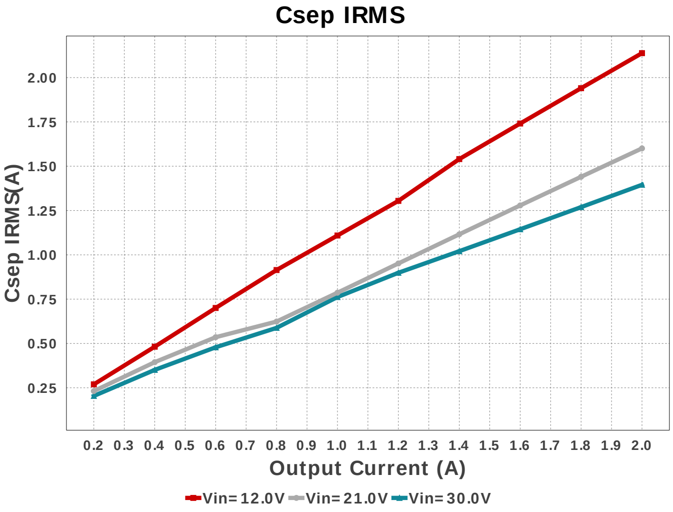

Lin Ipk
Lin Ipk(A)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

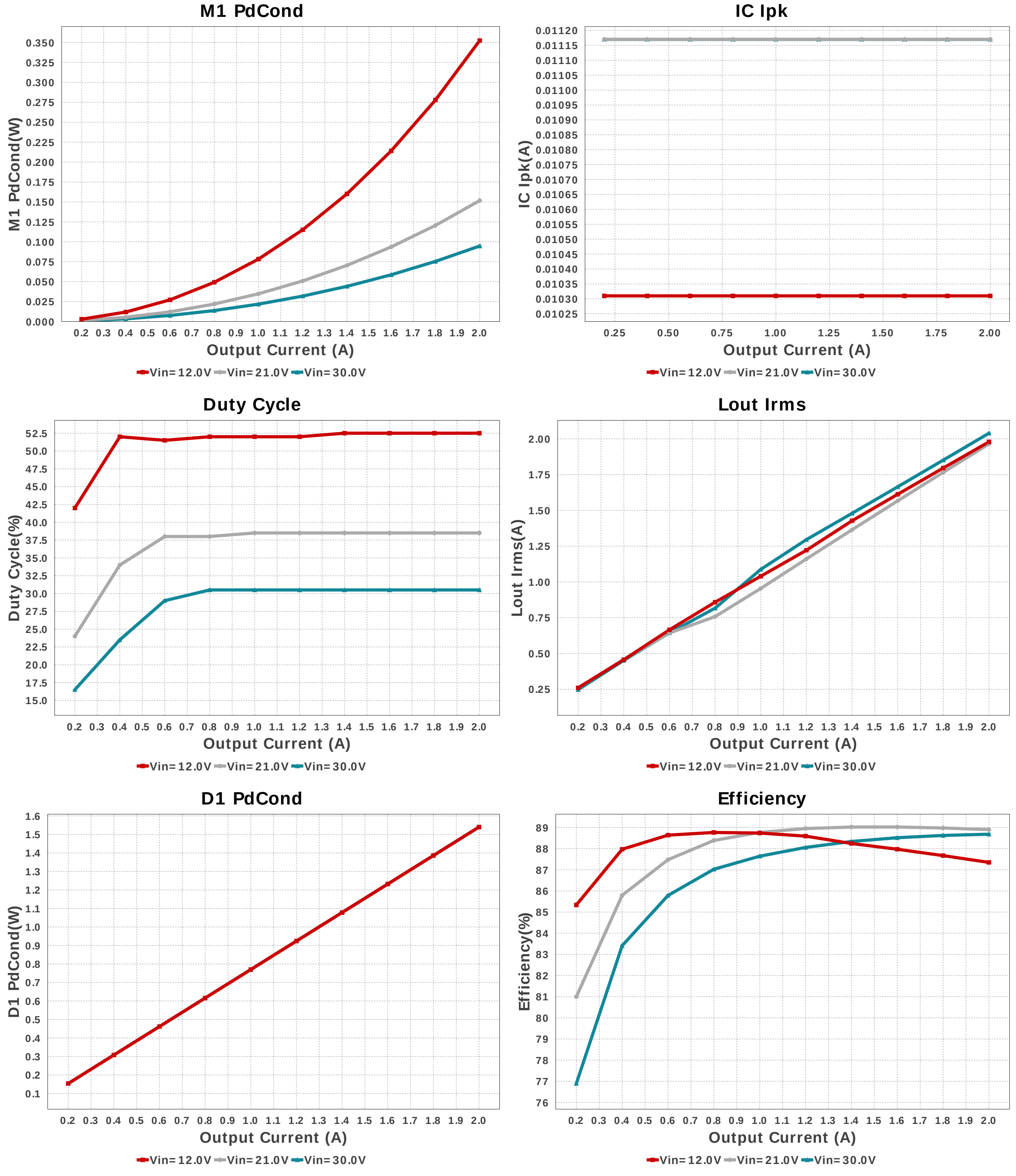

D1 Tj
D1 Tj(degC)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

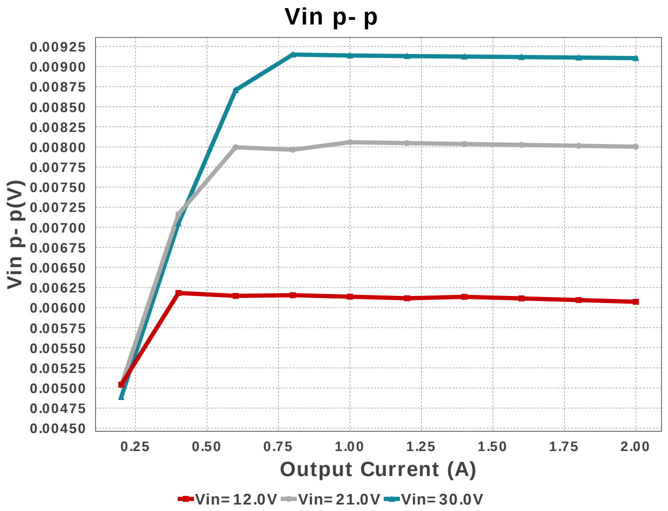

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

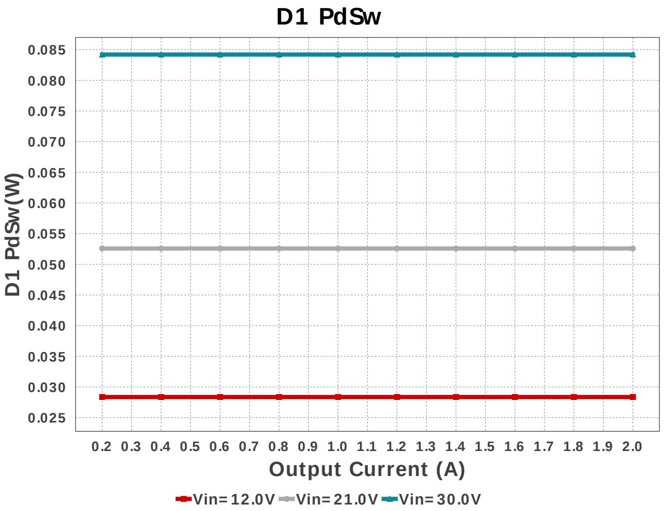

IC Tj
IC Tj(degC)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

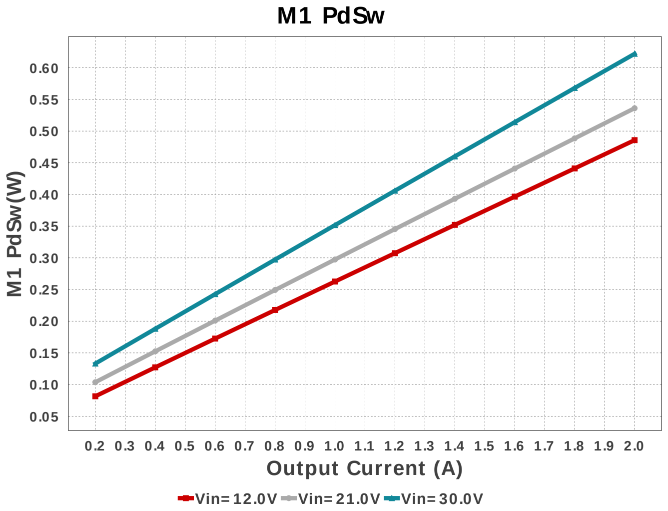

M1 TjOP
M1 TjOP(degC)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

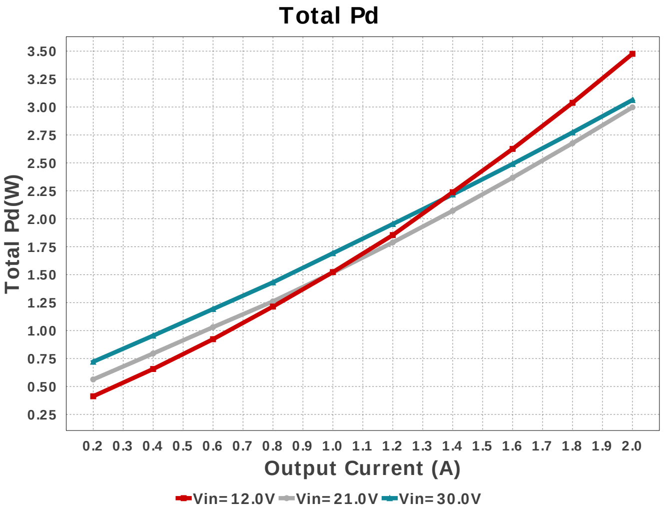

Csep IRMS
Csep IRMS(A)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

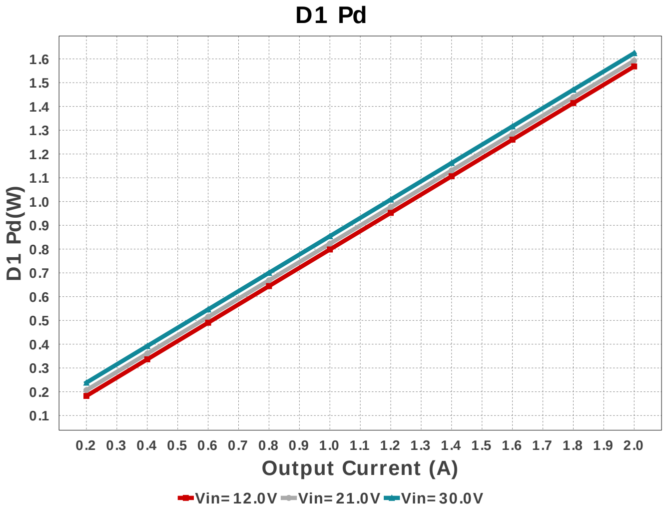

M1 PdCond
M1 PdCond(W)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V
IC Ipk
IC Ipk(A)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V
Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V
Lout Irms
Lout Irms(A)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V
D1 PdCond
D1 PdCond(W)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V
Efficiency
Efficiency(%)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

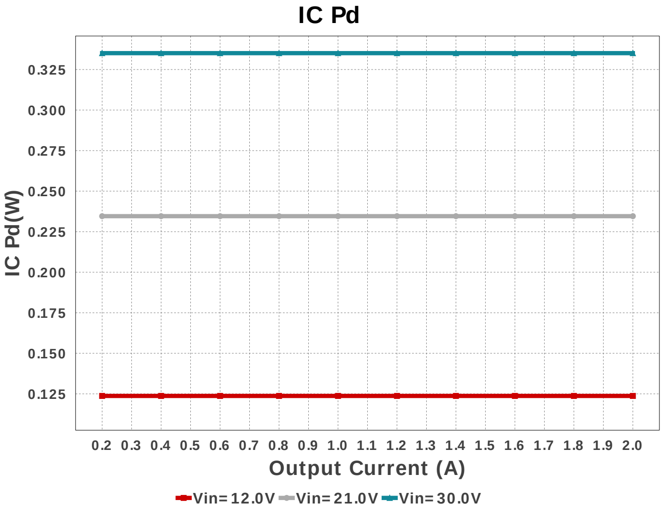

Vin p- p
Vin p- p(V)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

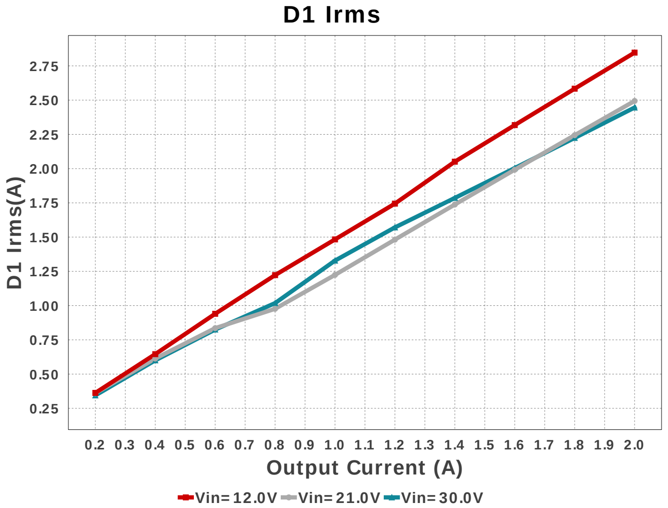

D1 PdSw
D1 PdSw(W)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

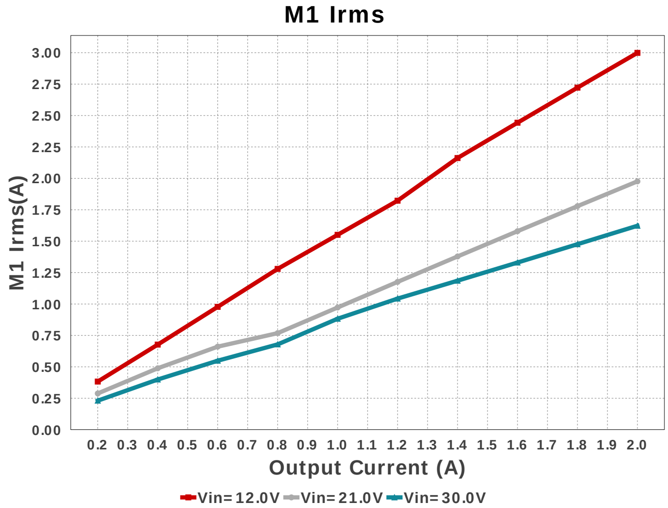

M1 PdSw
M1 PdSw(W)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

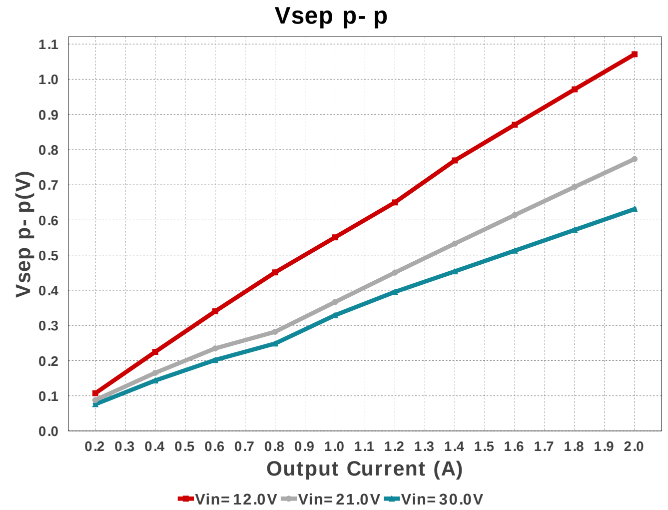

Total Pd
Total Pd(W)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

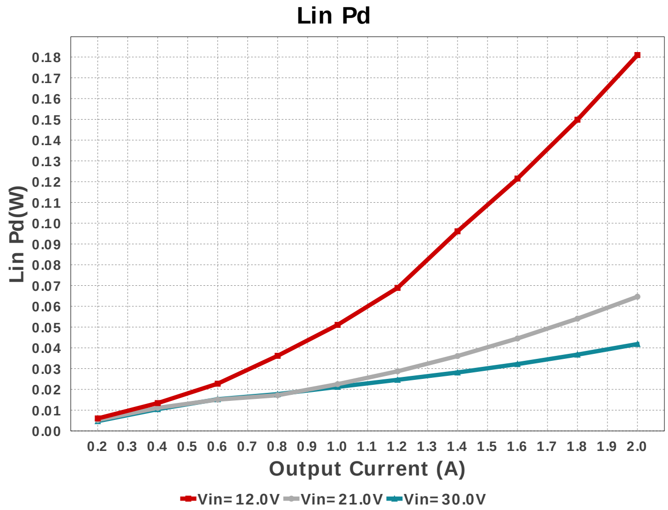

D1 Pd
D1 Pd(W)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

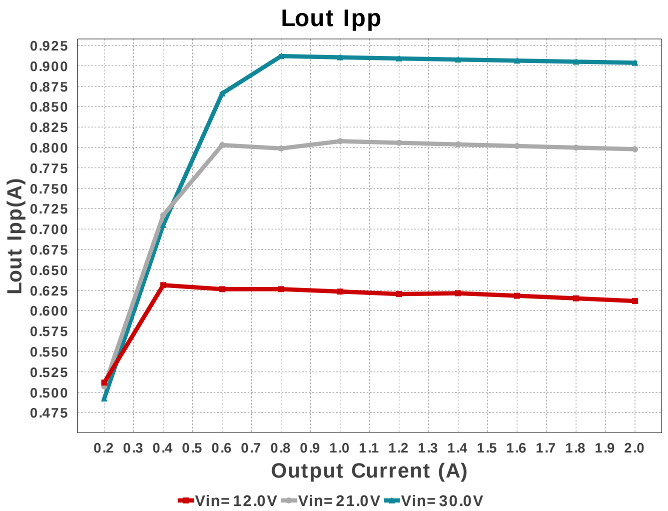

IC Pd
IC Pd(W)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

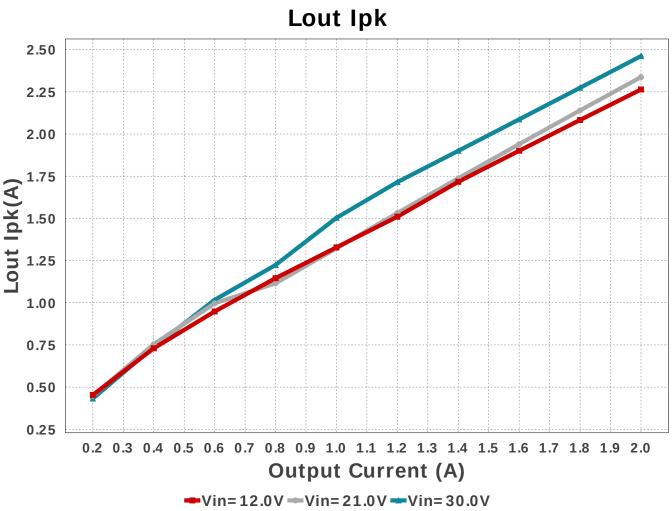

D1 Irms
D1 Irms(A)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

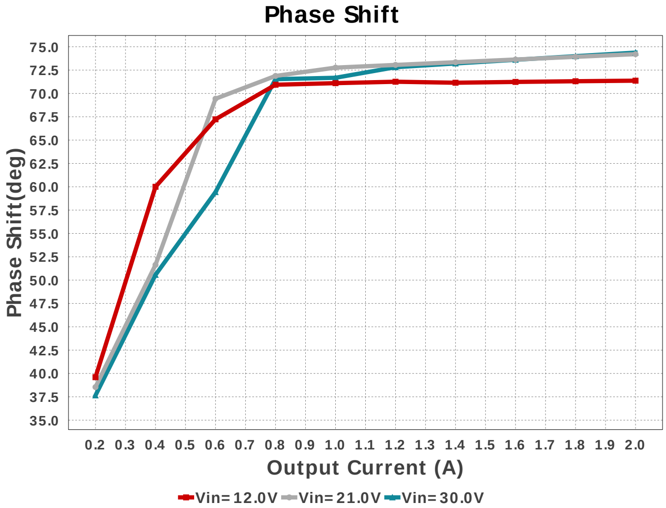

M1 Irms
M1 Irms(A)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

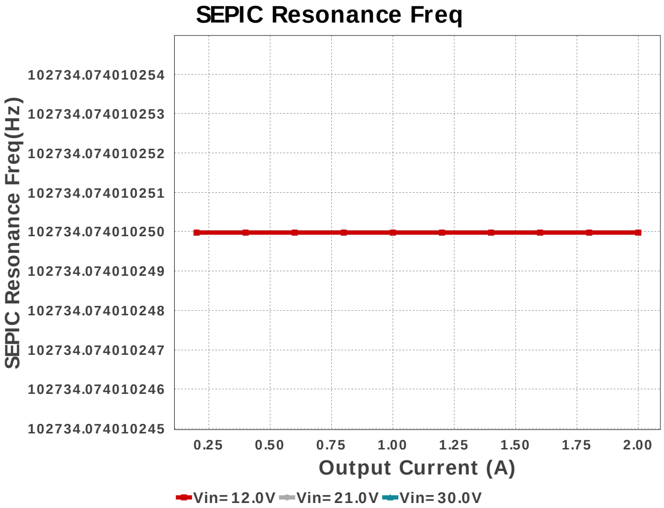

Vsep p-p
Vsep p-p(V)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

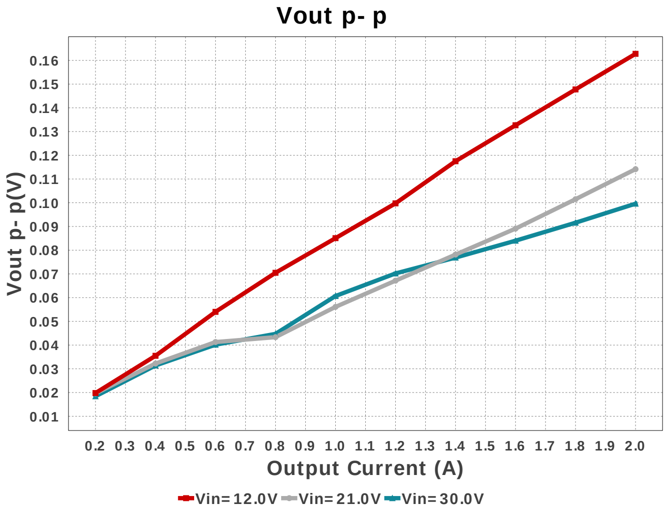

Lin Pd
Lin Pd(W)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

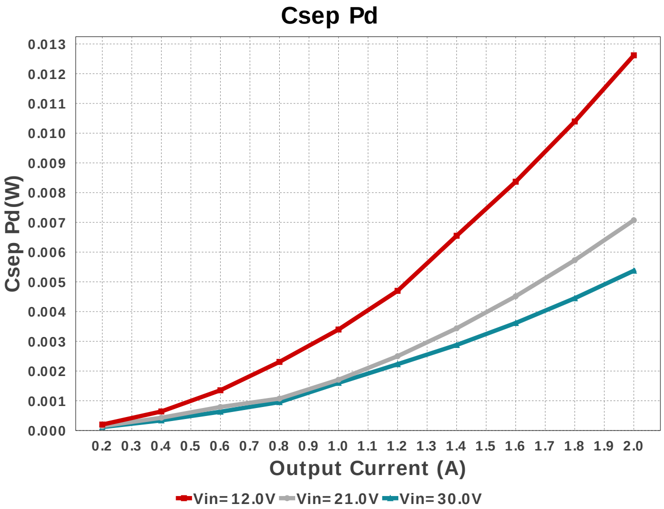

Lout Ipp
Lout Ipp(A)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

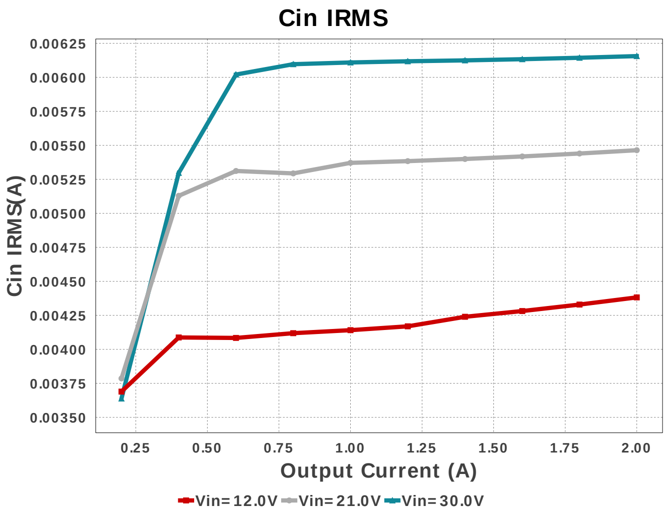

Lout Ipk
Lout Ipk(A)
Output Current (A)
Vin=12.0V Vin=21.0V Vin=30.0V

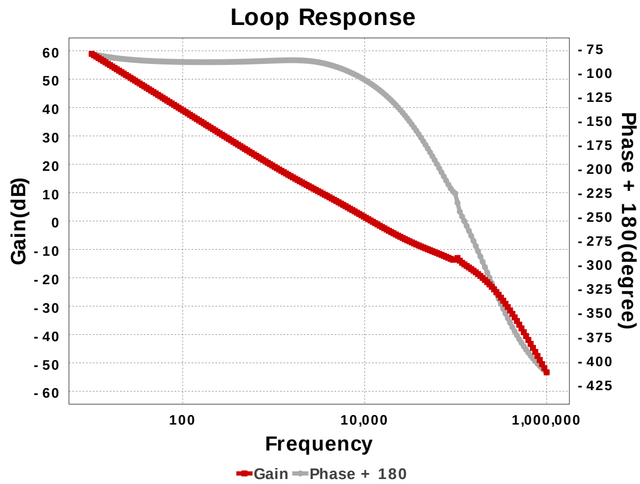












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	3.915 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	6.745 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	2.062 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	12.914 mW	Capacitor	Output capacitor power dissipation
5.	Csep IRMS	2.119 A	Capacitor	SEPIC capacitor RMS ripple current
6.	Csep Pd	12.396 mW	Capacitor	SEPIC capacitor power dissipation
7.	D1 Irms	2.84 A	Current	D1 Irms
8.	Lin Ipk	2.415 A	Current	Lin peak current
9.	Lin Irms	2.153 A	Current	Lin ripple current
10.	Lout Ipk	2.232 A	Current	Lout peak current
11.	Lout Irms	1.973 A	Current	Lout ripple current

#	Name	Value	Category	Description
12.	D1 Pd	1.571 W	Diode	Diode power dissipation
13.	D1 PdCond	1.54 W	Diode	Diode conduction losses
14.	D1 PdSw	31.202 mW	Diode	Diode switching losses
15.	D1 Tj	77.136 degC	Diode	D1 junction temperature
16.	IC Ipk	11.285 mA	IC	Peak switch current in IC
17.	IC Pd	338.55 mW	IC	IC power dissipation
18.	IC Tj	97.71 degC	IC	IC junction temperature
19.	IC Tolerance	25.0 mV	IC	IC Feedback Tolerance
20.	Iin Avg	2.294 A	IC	Average input current
21.	SEPIC Resonance Freq	102.734 kHz	IC	SEPIC Resonance Frequency
22.	Vsep p-p	966.877 mV	IC	Peak-to-peak sepic voltage
23.	Lin Ipp	563.962 mA	Inductor	Peak-to-peak input inductor ripple current
24.	Lout Ipp	555.886 mA	Inductor	Peak-to-peak output inductor ripple current
25.	M1 Irms	2.99 A	Mosfet	M1 MOSFET Irms
26.	M1 Pd	892.023 mW	Mosfet	M1 MOSFET total power dissipation
27.	M1 PdCond	356.663 mW	Mosfet	M1 MOSFET conduction losses
28.	M1 PdSw	535.359 mW	Mosfet	M1 MOSFET switching losses
29.	M1 TjOP	74.602 degC	Mosfet	M1 MOSFET junction temperature
30.	IOUT_OP	2.0 A	Op Point	Iout operating point
31.	VIN_OP	12.0 V	Op Point	Vin operating point
32.	Lin Pd	179.559 mW	Power	Lin power dissipation
33.	Lout Pd	151.293 mW	Power	Lout power dissipation
34.	Total Pd	3.527 W	Power	Total Power Dissipation
35.	Rsense Pd	536.269 mW	Resistor	LED Current Rsns Power Dissipation
36.	BOM Count	23	System Information	Total Design BOM count
37.	Cross Freq	11.623 kHz	System Information	Bode plot crossover frequency
38.	Duty Cycle	52.5 %	System Information	Duty cycle
39.	Efficiency	87.187 %	System Information	Steady state efficiency
40.	FootPrint	660.0 mm^2	System Information	Total Foot Print Area of BOM components
41.	Frequency	550.0 kHz	System Information	Switching frequency
42.	Gain Marg	10.29 db	System Information	Bode Plot Gain Margin
43.	Mode	CCM	System Information	Conduction Mode
44.	Phase Marg	68.776 deg	System Information	Bode Plot Phase Margin
45.	Phase Shift	70.33 deg	System Information	Bode Plot Phase Shift
46.	Total BOM	$3.97	System Information	Total BOM Cost
47.	Vin p-p	5.513 mV	System Information	Peak-to-peak input voltage
48.	Vout p-p	148.896 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	2.0	Maximum Output Current
VinMax	30.0	Maximum input voltage
VinMin	12.0	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	LM5022	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature

WEBENCH® Assembly

Component Testing

Some published data on components in datasheets such as Capacitor ESR and Inductor DC resistance is based on conservative values that will guarantee that the components always exceed the specification. For design purposes it is usually better to work with typical values. Since this data is not always available it is a good practice to measure the Capacitance and ESR values of Cin and Cout, and the inductance and DC resistance of L1 before assembly of the board. Any large discrepancies in values should be electrically simulated in WEBENCH to check for instabilities and thermally simulated in WebTHERM to make sure critical temperatures are not exceeded.

Soldering Component to Board

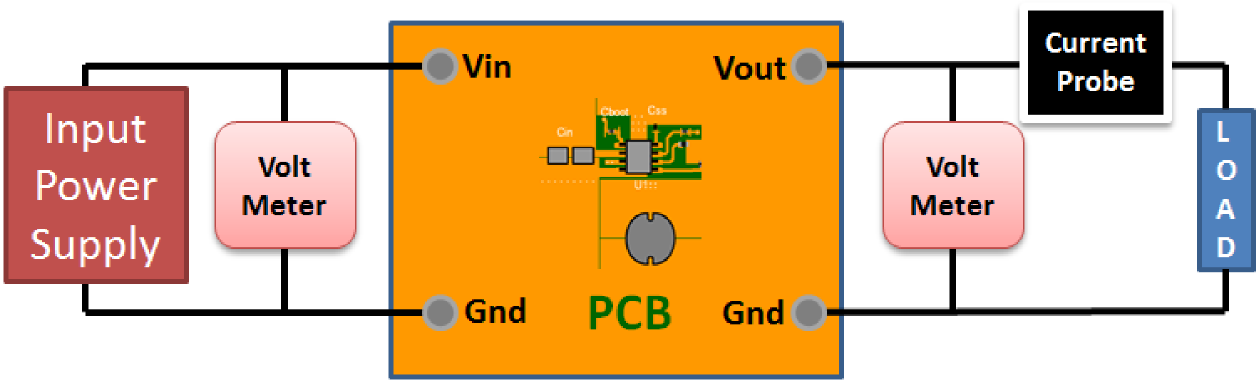
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab town to the board place the iron down on the board while resting against the tab, heating both surfaces simultaneously. Apply light pressure to the top of the plastic case until the solder flows around the part and the part is flush with the PCB. If the solder is not flowing around the board you may need a higher wattage iron (generally 25W to 30W is enough).

Initial Startup of Circuit

It is best to initially power up the board by setting the input supply voltage to the lowest operating input voltage 12.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to Vin and GND. Connect a digital volt meter and a load if needed to set the minimum Iout of the design from Vout and GND. Turn on the input supply and slowly turn up the current limit on the input supply. If the voltage starts to rise on the input supply continue increasing the input supply current limit while watching the output voltage. If the current increases on the input supply, but the voltage remains near zero, then there may be a short or a component misplaced on the board. Power down the board and visually inspect for solder bridges and recheck the diode and capacitor polarities. Once the power supply circuit is operational then more extensive testing may include full load testing, transient load and line tests to compare with simulation results.

Load Testing

The setup is the same as the initial startup, except that an additional digital voltmeter is connected between Vin and GND, a load is connected between Vout and GND and a current meter is connected in series between Vout and the load. The load must be able to handle at least rated output power + 50% (7.5 watts for this design). Ideally the load is supplied in the form of a variable load test unit. It can also be done in the form of suitably large power resistors. When using an oscilloscope to measure waveforms on the prototype board, the ground leads of the oscilloscope probes should be as short as possible and the area of the loop formed by the ground lead should be kept to a minimum. This will help reduce ground lead inductance and eliminate EMI noise that is not actually present in the circuit.



Design Assistance

1. Master key : A353B67D62C1BA9A[v1]

2. **LM5022** Product Folder : http://www.ti.com/product/LM5022 : contains the data sheet and other resources.

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